FORM PTO-1390 (Modified) (REV 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER	
56881 (45107)	
U.S. APPLICATION NO. (IF KNOWN, SEE 37 CFR	
10/048113	
INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE
PCT/DE00/02295	13 July 2000
PRIORITY DATE CLAIMED	
28 July 1999	

TITLE OF INVENTION

OPTOELECTRONIC COMPONENT AND METHOD FOR THE PRODUCTION THEREOF

APPLICANT(S) FOR DO/EO/US

Hans-Ludwig ALTHAUS, Gerhard KUHN, and Wolfgang GRAMANN

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (24) indicated below.
4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. ☒ A copy of the International Application as filed (35 U.S.C. 371 (c) (2))
   a. ☒ is attached hereto (required only if not communicated by the International Bureau).
   b. ☐ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).
7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.
8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).
10. ☐ An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371 (c)(5)).
11. ☒ A copy of the International Preliminary Examination Report (PCT/IPEA/409).
12. ☒ A copy of the International Search Report (PCT/ISA/210).

Items 13 to 20 below concern document(s) or information included:

13. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
14. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
15. ☒ A **FIRST** preliminary amendment. **(total 5 pages)**
16. ☐ A **SECOND** or **SUBSEQUENT** preliminary amendment.
17. ☐ A substitute specification.
18. ☐ A change of power of attorney and/or address letter.
19. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
20. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).
21. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
22. ☒ Certificate of Mailing by Express Mail
23. ☒ Other items or information:

    PCT Request (ANTRAG)

U.S. APPLICATION NO (IF KNOWN, SEE 37 CFR 1.5)	INTERNATIONAL APPLICATION NO.	ATTORNEY'S DOCKET NUMBER
10/048115	PCT/DE00/02295	56881 (45107)

24. The following fees are submitted:.	CALCULATIONS PTO USE ONLY
BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :	
☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	
☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	
☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**	
☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☒ 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).	**$130.00**

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	21 - 20 =	1	x $18.00	**$18.00**
Independent claims	2 - 3 =	0	x $84.00	**$0.00**
Multiple Dependent Claims **(check if applicable)**.			☐	**$0.00**
TOTAL OF ABOVE CALCULATIONS =				**$1,038.00**
☐ Applicant claims small entity status. See 37 CFR 1.27). The fees indicated above are reduced by 1/2.				**$0.00**
SUBTOTAL =				**$1,038.00**
Processing fee of **$130.00** for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492 (f)). +				**$0.00**
TOTAL NATIONAL FEE =				**$1,038.00**
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31) **(check if applicable).** ☐				**$0.00**
TOTAL FEES ENCLOSED =				**$1,038.00**
				Amount to be: refunded $
				charged $

a. ☒ A check in the amount of **$1,038.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. _____ in the amount of _____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. **04-1105** A duplicate copy of this sheet is enclosed.

d. ☐ Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

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SIGNATURE

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33,860
REGISTRATION NUMBER

JANUARY 25, 2002
DATE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: Hans-Ludwig ALTHAUS et al.

EXPRESS MAIL LABEL NO. EL 885010365 US

FOR: OPTOELECTRONIC COMPONENT AND METHOD FOR PRODUCTION THEREOF

Honorable Commissioner of Patents and Trademarks
Washington, DC 20231

Dear Sir:

PRELIMINARY AMENDMENT

Applicants file herewith the above-identified application. Please amend the application as follows.

IN THE CLAIMS

Please cancel claims 1-21 without prejudice.

Please add the following new claims.

22. Optoelectronic component comprising a light-emitting element and a system carrier which supports the element, for supporting or mounting the component, an auxiliary carrier made of a thermally conductive material being provided, at least regions of which are transparent or at least translucent for light, which is connected to the system carrier, on the one hand, and is thermally coupled to the element, on the other hand, and in which a recess is provided, through which the light passes, the recess in the auxiliary carrier being covered with a thin covering layer formed from the latter, through which the light passes,

wherein
a light-sensitive sensor is provided, which is formed on/in the element or on/in the substrate of the auxiliary carrier,
an optical arrangement which focuses, and/or which modifies the beam path of the light, is provided in the optical axis of the a component, and
the sensor is arranged in a region in which the optical arrangement which focuses, and/or which modifies the beam path of the light, reflects some of a light beam emitted by the element.

23. Optoelectronic component according to Claim 22, wherein the auxiliary carrier has an electrical bonding, by means of which it is electrically connected to the element.

24. Optoelectronic component according to Claim 22, wherein the auxiliary carrier is arranged between the system carrier and the element, and the auxiliary carrier and the element are mechanically connected in a substantially planar fashion.

25. Optoelectronic component according to Claim 22, wherein the system carrier, composed of a non-transparent material, is provided with an opening through which light passes.

26. Optoelectronic component according to Claim 22, wherein the recess in the auxiliary carrier and/or the opening of the system carrier has the configuration of a truncated cone or truncated pyramid or of a cylinder, the walls of said recess and/or opening having smooth lateral faces.

27. Optoelectronic component according to Claim 22, wherein the optical arrangement is fitted inside the opening of the system carrier and/or the recess of the auxiliary carrier.

28. Optoelectronic component according to Claim 22, wherein the optical arrangement is formed as a lens or a transparent platelet, the platelet being arranged at a defined angle between its surface normal and the optical axis of the component.

29. Optoelectronic component according to Claim 28, wherein the angle of the platelet arrangement is selected in such a way that a smallest possible proportion of light is reflected by the surface of the platelet, and/or a predetermined proportion thereof is reflected in a defined direction.

30. Optoelectronic component according to Claim 22, wherein a bonding or adhesive agent is provided, by means of which the optical arrangement is fixed inside the opening of the system carrier and/or the recess of the auxiliary carrier.

31. Optoelectronic component according to Claim 22, wherein in relation to the optical axis of the component, predetermined support points or support edges for the self-adjusting alignment of the optical arrangement are provided on the lateral faces and/or edges of the recess of the auxiliary carrier and/or the lateral faces and/or edges of the opening of the system carrier.

32. Optoelectronic component according to Claim 31, wherein the support points or support edges are arranged on the outermost edges, facing away from the element, of the recess and/or on the outermost edges, facing away from the element, of the opening and/or on a middle section of the opening wall or recess wall (lateral faces of the opening or recess) (9b or 2c).

33. Optoelectronic component according to Claim 22, wherein the sensor is formed by an active electronic component, in particular semiconductor component, structured in/on the auxiliary carrier (2), or the covering layer formed therefrom, or the element.

34. Optoelectronic component according to Claim 22, wherein the sensor is electrically coupled to the element, either indirectly via another circuit or directly.

35. Optoelectronic component according to Claim 33, wherein the semiconductor component is formed by a diode or a transistor.

36. Optoelectronic component according to Claim 22, wherein the auxiliary carrier has a substrate made of silicon or of an SiC compound, or is formed by such a material.

37. Optoelectronic component according to Claim 22, wherein the element is formed by a VCSEL chip having a coherently radiating diode, an IRED chip, a chip having a spontaneously emitting diode or such a chip emitting light on a surface.

38. Optoelectronic component according to Claim 22, wherein the system carrier, with the auxiliary carrier attached thereto, is potted or moulded at least in some areas with a non-transparent pressing, casting or moulding mass.

39. A method for producing an optoelectronic component, comprising a light-emitting or light receiving element and a system carrier, for supporting or mounting the component, comprising steps of:

providing an auxiliary carrier made of a thermally conductive material, at least regions of which are transparent or at least translucent for the light, by fabricating a recess for unimpeded passage of light in the auxiliary carrier by anisotropic etching,

connecting the auxiliary carrier to the element, while producing thermal coupling between the auxiliary carrier and the element, and

mechanical connecting the auxiliary carrier, carrying the element, to the system carrier, a covering layer with a thickness of 50 μm, which covers the recess, being left in place during the etching of the recess,

wherein a sensor, which is independent of light emitting or light receiving element element, is formed by semiconductor-technological structuring steps on/in the auxiliary carrier and/or the light emitting or light receiving element, before the connection thereof, and an optical arrangement is fixed in an opening of the system carrier, the sensor and the optical arrangement being arranged in such a way that the optical arrangement which focuses, and/or which modifies

the beam path of the light, reflects onto the sensor some of a light beam emitted by the light emitting or light receiving element.

40. The method for producing an optoelectronic component according to Claim 39, wherein a plurality of auxiliary carriers, which are to be separated in a further process step, are connected jointly in a composite structure with independent sensors and/or with the elements to be connected thereto.

41. The method for producing an optoelectronic component according to Claim 39, wherein the optical arrangement is bonded into the opening by means of a bonding or adhesive agent.

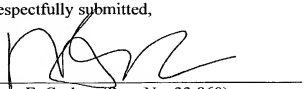
42. The method for producing an optoelectronic component according to Claim 39, wherein the system carrier, with the auxiliary carrier attached thereto and the light emitting or light receiving element located thereon, is potted or moulded at least in some areas with a non-transparent pressing, casting or moulding mass.

REMARKS

To reduce initial filing fees and place the claims in U.S. format, claims 1-21 have been cancelled without prejudice, and claims 22-42 have been added. No new matter has been added.

Early consideration and allowance of the application are earnestly solicited.

Respectfully submitted,



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Description

Optoelectronic component and method for the production thereof

The invention relates to an optoelectronic component with a light emitting or light receiving element and a system carrier supporting said element for the support or installation of said component, an auxiliary carrier transparent to light in at least some areas or at least translucent and made of heat conducting material being provided, said auxiliary carrier being connected to the system carrier and thermally coupled to the element and having a recess through which light passes, together with a method for manufacturing such an optoelectronic component.

Light emitting or receiving optoelectronic components are becoming increasingly important with a view to providing fast and reliable data transmission media. In such components an optical coupling of the active element, usually made of semiconductor materials, to the environment or to an optical fibre is necessary. This places increased requirements on the housings which enclose the semiconductor elements, which must ensure adequate stability for use of the components under usual conditions.

Technologies used up to now for constructing surface emitting or receiving optoelectronic components such as light emitting diodes (LEDs) as incoherent light sources, or in particular surface emitting laser diodes, so-called VCSELs (Vertical Cavity Surface Emitting Lasers) as coherent light sources, have been manufactured up to now in metal housings of relatively large dimensions (in relation to the desired degree of miniaturisation) (TO housings) with transparent windows, and usually with very complex and therefore expensive manufacturing techniques. Also known are less expensive structures with completely moulded transparent housings of plastics material (for example, the customary LED

housing) or pre-moulded plastic housings with moulded-in transparent plastic portions. The disadvantage of these constructions, in particular of the cheap construction of the LED plastic moulding-in technique which finds billions of applications, lies in the fact, in particular in the case of VCSEL diodes, that when manufactured with transparent plastics materials these components cannot be produced with sufficient optical quality and/or mechanical precision for coupling to an optical fibre. For this reason only the expensive TO housings with inset optical window cap have been used up to now.

A further difficulty with regard to the required miniaturisation results from the necessity when operating some optoelectronic components to incorporate a sensor or detector monitoring the operation or adjustment of the component in the housing of the optoelectronic component. According to the prior art, as shown in EP 0 786 836 A2, this is effected by the complex installation e.g. of monitor diodes in the TO housing used. This construction is very complex with regard both to the housing materials used and to the manufacturing steps, and thus is cost-intensive. However, for manufacturing reasons, the less expensive construction by the plastic moulding-in technique permits only limited incorporation of additional monitoring functions by additional elements. A further major disadvantage of the plastic moulding-in technique is that, when used with fibre optics, the stability of the structures and materials used for the plastic housing body is insufficient for precise coupling of the connected fibres. Plastic housing bodies can therefore be used for secure coupling only up to a maximum glass fibre diameter of 50 µm, and in particular cannot be used for single-mode fibres.

A further problem with optically emitting components is power loss in light generation. The heat arising in such components reduces the optical conductivity, sometimes substantially, by heating up the active light emitting zones.

Known from DE 195 27 026 A1 is an optoelectronic component which has a radiation emitting and/or receiving semiconductor element as the light emitting or receiving element. The semiconductor element is fixed to a carrier plate which rests on a base plate with an opening. The radiation emitted from the semiconductor element can pass out through the carrier platet and the opening in the base plate. To focus the radiation emitted by the semiconductor element the carrier plate has a lens configuration in the area of the opening in the base plate.

Known from Patent Abstracts of Japan, E-1290, 1992, Vol. 16/No. 542, JP 4-207079 A is a layer construction on a substrate in which a photodiode is formed to detect the light emitted to the layer construction.

Further known from US 4,967,241 is a layer construction on a substrate in which a funnel-shaped passage is formed for the light emitted by the layer construction. A photodiode is formed in the substrate to detect the light emitted from the layer construction.

Finally, Patent Abstracts of Japan, E-712, 1989, Vol. 13/No. 51, JP 63-244781 A discloses a tubular housing with a funnel-shaped opening behind which a light emitting element is mounted. The light emitted by the light emitting element is focused by a spherical lens arranged in the funnel-shaped opening.

It is the object of the invention to make available an optoelectronic component which can be manufactured at low cost and with the necessary optical qualities, and which reduces the heat generated in the element through energy dissipation and ensures good optical imaging or coupling out of the light.

This object is achieved with regard to the device according to the features of claim 1 and with regard to the method according to the features of claim 21.

According to the invention an auxiliary carrier which is transparent at least in some areas or is at least translucent and is made of heat conductive material is provided, and firstly is connected to the system carrier and secondly is thermally coupled to the element. The feature "transparent in some areas or at least translucent" means that either the material of the auxiliary carrier itself is transparent or an opening or at least a recess allowing the passage of light is provided.

The invention further proposes to provide an auxiliary carrier for the light emitting or receiving element, which carrier ensures optimal thermal conduction in particular to the system carrier - while being of very small dimensions - and at the same time does not obstruct the inward or outward passage of light or ensures a targeted emission of light. A further advantage resulting from this feature is that the mounting of the element connected to the auxiliary carrier on the system carrier is substantially simplified since the dimensions of the system carrier are larger than those of the element alone and the auxiliary carrier is less sensitive when manipulated.

Following the principle of the invention a recess through which light passes is provided in the auxiliary carrier. Through said recess light rays for which the material of the auxiliary carrier is insufficiently transparent or is completely non-translucent can also penetrate the auxiliary carrier. To this end the recess is covered by a thin, light-permeable covering layer formed from said auxiliary carrier. The thickness of the light-absorbent material through which the light must pass is thereby reduced to a minimum. It is possible to form a sensor through which light is to pass in the relatively thin covering layer.

According to a preferred embodiment of the invention the auxiliary carrier is mechanically connected to the element in a planar fashion. Good heat dissipation from the element into the auxiliary carrier and a secure connection are thereby ensured. The auxiliary carrier is advantageously connected electrically to the

element by means of an electrical bonding, facilitating current supply and signal conductance.

According to a further advantageous and therefore preferred embodiment of the invention a light-sensitive sensor is formed on or in the auxiliary carrier. Likewise, according to another advantageous embodiment of the invention a light-sensitive sensor is formed on or in the element. The advantage of this arrangement is that a sensor no longer needs to be installed in the housing incorporating the element by means of complex assembly steps. The direct integration in the auxiliary carrier makes it possible during irradiation of same to detect, for example, the quality or quantity of the emitted or received light independently of the element. Through such forming of a sensor in the auxiliary carrier or in the element itself complex and costly manufacturing steps can be saved and the efficiency of production can be improved.

According to a further aspect of the invention the system carrier is provided with an opening which allows light to pass through said system carrier. According to these embodiments the recess in the auxiliary carrier and/or the opening in the system carrier advantageously has the form of a truncated cone or truncated pyramid or is cylindrical with smooth side faces. By this means a divergent beam can emerge unobstructed and an incident beam can be concentrated by suitable measures into the area through which light passes.

According to a further preferred embodiment of the invention a focusing arrangement and/or an arrangement which changes the beam path of the light is advantageously arranged in the optical axis of the component. The quality and form of the beam and the coupling in and out of the light can thereby be advantageously influenced. Accordingly, in one embodiment of the invention the optical arrangement is advantageously fitted inside the opening of the system carrier and/or the recess of the auxiliary carrier.

According to a further advantageous aspect of the invention the optical arrangement is formed as a lens or a transparent platelet which is arranged between the surface normal of said platelet and the optical axis of the component at a defined angle which, according to another advantageous embodiment of the invention, is so selected that the smallest possible proportion of the emitted light is reflected by the surface of the platelet, and/or that a predetermined proportion is reflected in a defined direction. Through the reflection of a proportion of the emitted light, said proportion can be coupled into the sensor for evaluation.

An adhesive or bonding agent by means of which the optical arrangement is fixed inside the opening of the system carrier is preferably provided. A secure fixing of the optical arrangement is thereby achieved.

Advantageously, predetermined support points or support edges are provided on the side faces and/or edges of the recess of the auxiliary carrier and/or the side faces and/or edges of the opening in the system carrier for the self-adjusting alignment of the optical arrangement with respect to the optical axis of the component. A complex and error-prone positioning of the optical arrangement with respect to the element is thereby eliminated. Rapid and low-cost positioning of the optical arrangement is therefore possible. Consequently the support points or support edges are advantageously arranged on the outermost edges of the recess facing away from the element and/or on the outermost edges of the opening facing away from the element and/or on a middle section of the wall of the opening or recess.

According to a further preferred aspect of the invention the sensor is formed by an active electronic component, in particular a semiconductor component structured in or on the auxiliary carrier or its covering layer or in or on the element, the auxiliary carrier consisting preferably of a silicon substrate or a silicon-carbon compound and, according to another further development, the sensor is electrically coupled to the element indirectly via another circuit or

directly. This makes possible a particularly reliable and inexpensive integration of the sensor, which is advantageously formed by a diode or a transistor, into the auxiliary carrier or into the element.

According to an especially preferred embodiment of the invention the element is formed by a VCSEL chip (coherently radiating diodes), an IRED chip (IRED = InfraRed Emitting Diode), spontaneously emitting diodes, or another chip emitting light on one surface. The resulting heat generated by energy dissipation is quickly dissipated through the good thermal conductivity of the auxiliary carrier to the system carrier connected thereto, so that reliable operation unrestricted by heat build-up is possible. The light emitting lateral face faces towards the auxiliary carrier which is irradiated by the light.

According to a further embodiment of the invention the system carrier is at least partially encapsulated with the auxiliary carrier fixed to it, by a non-transparent pressing, casting or moulding mass. Safe handling and reliable operation of the optoelectronic component are thereby ensured and miniaturisation of the housing, for example to SMD dimensions, is made possible.

The method for producing an optoelectronic component according to the invention, said component consisting of an element emitting or receiving light on a light transmitting surface and a system carrier supporting said element, provides for the connection of an auxiliary carrier transparent in at least some areas or at least translucent and made of thermoconductive material to the element, a thermal coupling between the auxiliary carrier and the element being produced. According to this method a mechanical connection of the auxiliary carrier supporting the element to the system carrier is provided.

A recess for the unimpeded passage of light through the auxiliary carrier is formed according to a process step according to the invention by anisotropic etching before connection of the auxiliary carrier to the element. Then, in a

further process step while etching the recess, a covering layer with a thickness of <= 50 µm and covering the recess is left in place. The formation of a light-permeable sensor even when an absorbent material is used for the auxiliary carrier is thereby made possible.

According to a further especially preferred process step the formation of a sensor independent of the element is provided on or in the auxiliary carrier and/or the element by means of structuring steps used in semiconductor technology, before connection of these parts.

According to a further advantageous process step a multiplicity of auxiliary carriers, to be separated in a further process step, is combined jointly in a composite structure with independent sensors and/or the elements to be connected to same.

Also preferred is the fixing of an optical arrangement in the opening of the system carrier, the optical arrangement being advantageously bonded into the opening by means of an adhesive or bonding agent.

The system carrier is advantageously encapsulated at least partially with the auxiliary carrier attached to it and the element located on it, by means of a non-transparent pressing, casting or moulding mass.

Further advantages, peculiarities and advantageous further developments of the invention emerge from the subsidiary claims.

The invention is further explained below with reference to the drawings. In the schematic representations:

Fig. 1 is a schematic cross-sectional representation of an optoelectronic component with a lens for clarification of the invention;

Fig. 2 is a schematic cross-sectional representation of a further optoelectronic component with an obliquely arranged outlet or inlet window for clarification of the invention;

Fig. 3 is a schematic cross-sectional representation of a further preferred embodiment of an optoelectronic component according to the invention with a coherently radiating laser diode and a lens, and

Fig. 4 is a schematic representation of the arrangement of the laser diode and the auxiliary carrier from Fig. 3 in a top view.

In Fig. 1 a section through an optoelectronic component is shown. An emitting element 1 which is thermally coupled and mechanically connected to an auxiliary carrier 2 is supported by a system carrier 9, the auxiliary carrier 2 being connected to the system carrier 9.

The element 1 is formed by a chip e.g. a spontaneously emitting diode or a VCSEL chip emitting light 13 on the light-transmitting surface 1a. The current is supplied via bonding wires 5 connected with solder (bondpad) 4 to conductive layers (metal coatings) 2d, which in turn conduct the current to the element 1. The conductive layers 2d are partially isolated from the element 1 and the auxiliary carrier 9 by insulating layers 6. Element 1 emits at the light transmitting surface 1a towards the auxiliary carrier 2 in order to dissipate as much as possible of the heat arising in that area to the active zone of element 1 through the thermal coupling to the auxiliary carrier 2.

For wavelengths of the out-coupled or in-coupled light 13 greater than 1200 nm the auxiliary carrier 2 can be made of silicon as this material is transparent to such light waves and has excellent heat conducting properties. In this case the light 13 is emitted by the light-transmitting surface 1a through the material of the

auxiliary carrier 2. In an application illustrated in Fig. 1 for light waves with a wavelength less than 1200 nm silicon is no longer sufficiently transparent and is therefore unsuitable. For an application in which no energy dissipation occurs, with the associated heat loss, glass is conceivable as the material for the auxiliary carrier 2. But as soon as heat must be dissipated, glass with its poor thermoconductive properties is no longer usable. For applications in which energy dissipation occurs, such as laser diodes (VCSEL diodes), therefore, materials with good thermal conductivity are used for the auxiliary carrier 2 in order to prevent heat build-up with the concomitant limitation of the functionality or the optical efficiency of the component.

In order nevertheless to utilise the good heat conducting properties of silicon without impeding the passage of the emitted light 13, a recess 2a is provided in the auxiliary carrier 2 made of silicon, said recess 2a being so arranged that the light-emitting area of light-transmitting surface 1a is arranged above the small recess 2a in the auxiliary carrier 2. The recess 2a can be produced by etching. In order to obtain good results with respect to the geometry of the recess 2a (a truncated cone or a truncated pyramid is the most suitable form) and with respect to the properties of the lateral faces 2c of the recess 2a, the anisotropic micro-mechanical etching technique is used. This technique makes it possible to produce the smallest possible truncated conical or pyramidal recess 2a (while still leaving sufficient material for heat dissipation) in the range of some tens of µm with a completely smooth and level assembly face (to which the element 1 or the system carrier 9 is attached).

The covering according to the invention for the recess 2a, which covering is formed by the auxiliary carrier 2 itself, is not illustrated in Fig. 1.

So that the emitted light 13 can further be radiated unimpeded from the component, an opening 9a, which likewise can have the form of a truncated cone or pyramid or of a cylinder and has smooth lateral faces, is provided in the

system carrier 9 connected to the auxiliary carrier 2. The opening 9a of the system carrier 9 is so configured that it can accommodate an optical arrangement for changing the beam form or the beam path, for example in the form of a focusing lens 11. An optimum coupling out of the light 13 can therefore be made possible. To fix the lens 11 securely and to isolate the emitting element 1 from the environment an adhesive agent 12 is provided to retain the lens 11 in the opening. Because a precise disposition of the optical arrangement with respect to the optical axis OA of the optoelectronic component is important for the operation of same, support points or support edges are provided on the outermost edges 2b of the recess 2a, facing away from the element 1, for the self-adjusting alignment of the lens 11, by which support points or edges the lens 11 aligns itself when being installed.

The lens 11 can therefore precisely image and couple in the emitted light beam, for example into an optical fibre, not illustrated. Instead of the outermost edges 2b of the recess 2a, the outermost edges 9c of the opening 9a facing away from the element 1, or a defined point in the central portion of the wall of the opening 9b or of the recess 2c, are also suitable as support edges.

To be able to monitor the operation of the emitting element 1 a sensor 3 is formed in the auxiliary carrier 2. This sensor is designed to be sensitive to the emitted light and is formed as a diode or a transistor with a doping range 3a. The sensor 3 is likewise connected by conductive layers 2d or bonding wires 5, or its signal is collected via same. It is also possible to design an electronic circuit to evaluate or process the signal of the sensor 3 in the auxiliary carrier.

In order to reflect a quantity 14 of the emitted light 13 sufficient for evaluation into the pn junction of the sensor 3 acting as a photodiode accessible on the lateral face 2c of the recess 2a, the lens is suitably coated. It is also possible to provide the sensor within the thin ($\leq$ 50 µm) layer covering the recess 2a (said layer being left in place when etching the recess). The light beam passes directly

through the covering layer. Because the layer is sufficiently thin only a small quantity (≤ 10%) of light is absorbed and used for evaluation (monitoring function).

The structure of element 1, auxiliary carrier 2 and system carrier 9 is enclosed for protection by a non-transparent moulding mass so formed that light is still able to pass out through the system carrier. The element 1 and the sensor 3 are thereby protected against unwanted secondary light or reflections and are easy to manipulate.

The construction according to the invention makes possible an electro-optically active, surface emitting component using leadframe moulding technology which contains a monitoring function in addition to its pure emission function. In particular optoelectronic SMD components, for example for producing fibre-optic components, are thereby made possible.

Fig. 2 shows a section through a variant of the optoelectronic component in which, in place of a lens, a platelet 21 transparent to the emitted light 13 is fixed into the opening 9a of the system carrier 9 with an adhesive agent 12 (in the drawings the same reference numerals denote the same or analogous constituents of the device according to the invention). The platelet can be fixed either in the opening 9a, as shown, or on the outside 9d of the system carrier 9 or on the lateral face 2f of the auxiliary carrier 2 facing away from the element 1.

The platelet 21 can be arranged (as shown in the example) at a defined angle 22 between its surface normal FN and the optical axis OA of the component. Optimum transmission properties of the platelet 21 and the directions and proportions 14 of the emitted light 13 reflected back for evaluation by the sensor 3 can thereby be set. The defined angle 22 can be so selected that a highest possible proportion of light is reflected by the surface 23 of platelet 21, which is suitably metallised or coated, on to the sensor area (monitor), or a highest

possible proportion passes through the platelet. It is also possible to provide a thin (≤ 50 µm) covering layer covering the sensor in the recess 2a. Here, too, the light passes directly through the covering layer. Because the layer is selected sufficiently thin, even in the case of absorbent material only a small quantity (<= 10%) of light is absorbed and used for evaluation (monitoring function).

A section through a further variant of an optoelectronic component with a VCSEL chip as the light emitting element 1 is illustrated in Fig. 3. Here SiC, which is optically transparent and has good thermal conductivity, is used as the material of the auxiliary carrier 2 in place of silicon. However, in this case the formation of a sensor in the auxiliary carrier by means of structuring steps used in semiconductor technology is only possible with very great complexity.

In the example, the sensor 3 for the desired monitoring function is itself formed in element 1 by a suitably doped area 33. Again, current is supplied and the signal is collected via bonding wires 5 bonded to bondpads 4 and is further fed to the VCSEL chip and to the sensor 3 via conductive layers 2d and a bonding face 37, the conductive layers being electrically connected to the current supply 34 and the bonding faces 35 via a bonding agent 36 (for example, solder).

In the opening 9a of the system carrier 9, produced by drilling in this example, a lens 11 is retained in said opening with an exact fit by lateral faces 9b. To improve the coupling of the laser light into or out of the auxiliary carrier 2 a material 31 can be used to reduce undesired effects (reflection or other effects influencing the beam).

Fig. 4 shows a top view of the element 1 formed as a VCSEL chip and of the auxiliary carrier 2 from Fig. 3 in the direction designated by reference character IV. The reference numerals correspond to those from Fig. 3.

Generally described in this document are optoelectronic components with a light emitting or light receiving element 1 and a system carrier 9 supporting the element 1 for the support or assembly of the component, an auxiliary carrier 2 which is transparent to light at least in some areas or is at least translucent and is made of heat conducting material being provided, said auxiliary carrier 2 being connected to the system carrier 9 and thermally coupled to the element 1.

Claims

1. Optoelectronic component with a light emitting or light receiving element (1) and a system carrier (9) supporting the element (1) for the support or assembly of said component, an auxiliary carrier (2) which is transparent to light at least in some areas or is at least translucent and is made of heat conducting material being provided, said auxiliary carrier (2) being connected to the system carrier (9) and thermally coupled to the element (1) and a recess (2a) through which the light passes being provided in said auxiliary carrier (2),
characterised in that
the recess (2a) is covered with a thin covering layer formed from said auxiliary carrier (2), through which covering layer the light passes.

2. Optoelectronic component according to claim 1,
characterised in that
the auxiliary carrier (2) has an electrical bonding whereby said auxiliary carrier (2) is electrically connected to the element (1).

3. Optoelectronic component according to claim 1 or 2,
characterised in that
the auxiliary carrier (2) is arranged between the system carrier (9) and the element (1) and the auxiliary carrier (2) and the element (1) are mechanically connected in a substantially planar fashion.

4. Optoelectronic component according to one of the claims 1 to 3,
characterised in that
the auxiliary carrier (2) has a light-sensitive sensor (3) formed in or on the same substrate.

5. Optoelectronic component according to one of the claims 1 to 3, characterised in that
a light-sensitive sensor which is formed on or in the element (1) is provided.

6. Optoelectronic component according to one of the claims 1 to 5, characterised in that
the system carrier (9) consisting of non-transparent material is provided with an opening (9a) through which light passes.

7. Optoelectronic component according to one of the claims 1 to 6, characterised in that
the recess (2a) in the auxiliary carrier (2) and/or the opening (9a) of the system carrier (9) has the configuration of a truncated cone or truncated pyramid or of a cylinder, the walls of said recess (2a) and/or opening (9a) having smooth lateral faces (2c).

8. Optoelectronic component according to one of the claims 1 to 7, characterised in that
an optical arrangement (11 or 21) which focuses and/or changes the beam path of the light is provided in the optical axis (OA) of the component.

9. Optoelectronic component according to claim 8, characterised in that
the optical arrangement (11 or 21) is fitted inside the opening (9a) of the system carrier (9) and/or the recess (2a) of the auxiliary carrier (2).

10. Optoelectronic component according to claim 8 or 9, characterised in that

the optical arrangement is formed as a lens (11) or a transparent platelet (21), the platelet (21) being arranged at a defined angle (22) between its surface normal (FN) and the optical axis (OA) of the component.

11. Optoelectronic component according to claim 10,
characterised in that
the angle (22) of the platelet arrangement is so selected that a smallest possible proportion of light is reflected by the surface (23) of the platelet (21), and/or in that a predetermined proportion (14) thereof is reflected in a defined direction.

12. Optoelectronic component according to one of the claims 8 to 11,
characterised in that
an adhesive or bonding agent (12) is provided by means of which the optical arrangement (11 or 21) is fixed inside the opening (9a) of the system carrier (9) and/or the recess (2a) of the auxiliary carrier (2).

13. Optoelectronic component according to one of the claims 8 to 12,
characterised in that
predetermined support points or support edges (2b) for the self-adjusting alignment of the optical arrangement (11 or 21) are provided with respect to the optical axis (OA) of the component on the lateral faces (2c) and/or edges of the recess (2a) of the auxiliary carrier (2) and/or on the lateral faces (9b) and/or edges of the opening (9a) of the system carrier (9).

14. Optoelectronic component according to claim 13,
characterised in that
the support points or support edges are arranged on the outermost edges (2b) of the recess (2a) facing away from the element (1) and/or on the outermost edges (9c) of the opening (9a) facing away from the element

(1) and/or on a middle section of the wall (= lateral faces) of the opening or recess (9b or 2c).

15. Optoelectronic component according to one of the claims 4 to 14, characterised in that
the sensor (3) is formed by an active electronic component, in particular a semiconductor component, structured in or on the auxiliary carrier (2) or in or on the covering layer formed from same or in or on the element (1).

16. Optoelectronic component according to one of the claims 4 to 15, characterised in that
the sensor (3) is electrically coupled to the element (1) indirectly via another circuit or directly.

17. Optoelectronic component according to claim 15 or 16, characterised in that
the semiconductor component is formed by a diode or a transistor.

18. Optoelectronic component according to one of the claims 1 to 17, characterised in that
the auxiliary carrier (2) has a substrate of silicon or an SiC compound or is formed by such a material.

19. Optoelectronic component according to one of the claims 1 to 18, characterised in that
the element (1) is formed by a VCSEL chip (VCSEL = Vertical Cavity Surface Emitting Laser) with a coherently radiating diode, an IRED chip (IRED = InfraRed Emitting Diode), a chip with a spontaneously emitting diode or a suchlike chip emitting light on a surface.

20. Optoelectronic component according to one of the claims 1 to 19, characterised in that
the system carrier (9) is encapsulated at least in some areas with the auxiliary carrier (2) attached to it by means of a non-transparent pressing, casting or moulding mass (10).

21. Method for producing an optoelectronic component consisting of a light emitting or light receiving element (1) and a system carrier (9) for the support or assembly of the component, with the process steps:
- provision of an auxiliary carrier (2) transparent to light at least in some areas or at least translucent and made of heat conducting material, a recess (2a) for the unimpeded passage of light being produced in the auxiliary carrier (2) by anisotropic etching,
- connection of the auxiliary carrier (2) to the element (1) while producing a thermal coupling between the auxiliary carrier (2) and the element (1), and
- mechanical connection of the auxiliary carrier (2) supporting the element (1) to the system carrier (9),
characterised in that
a covering layer with a thickness of ≤ 50 µm covering the recess is left in place while etching the recess (2a).

22. Method for producing an optoelectronic component according to claim 21, characterised in that
a sensor (3) independent with respect to the element (1) is formed by means of structuring steps used in semiconductor technology on or in the auxiliary carrier (2) and/or the element (1) before connecting same.

23. Method for producing an optoelectronic component according to claim 21 or 22,

characterised in that a multiplicity of auxiliary carriers (2), which are to be separated in a further process step, are connected jointly in a composite structure with independent sensors (3) and/or with the elements (1) to be connected to same.

24. Method for producing an optoelectronic component according to one of the claims 21 to 23, characterised in that an optical arrangement (11 or 21) is fixed in an opening (9a) of the system carrier (9).

25. Method for producing an optoelectronic component according to claim 24, characterised in that the optical arrangement (11 or 21) is bonded into the opening (9a) by means of an adhesive or bonding agent (12).

26. Method for producing an optoelectronic component according to one of the claims 21 to 25, characterised in that the system carrier (9) is encapsulated at least in some areas with the auxiliary carrier (2) attached to it and the element (1) located on it, by means of a non-transparent pressing, casting or moulding mass (10).

Abstract

Optoelectronic component and method for the production thereof

The invention relates to an optoelectronic component with a light emitting or light receiving element (1) and a system carrier (9) supporting the element (1). The element (1) emits or receives light on a light transmitting surface (1a), an auxiliary carrier (2) made of heat conductive material and transparent at least in some areas or at least translucent being provided. Said auxiliary carrier (2) is connected to the system carrier (9) and is thermally coupled to the element (1). The invention also relates to a method for the production of such an optoelectronic component.

Fig. 1

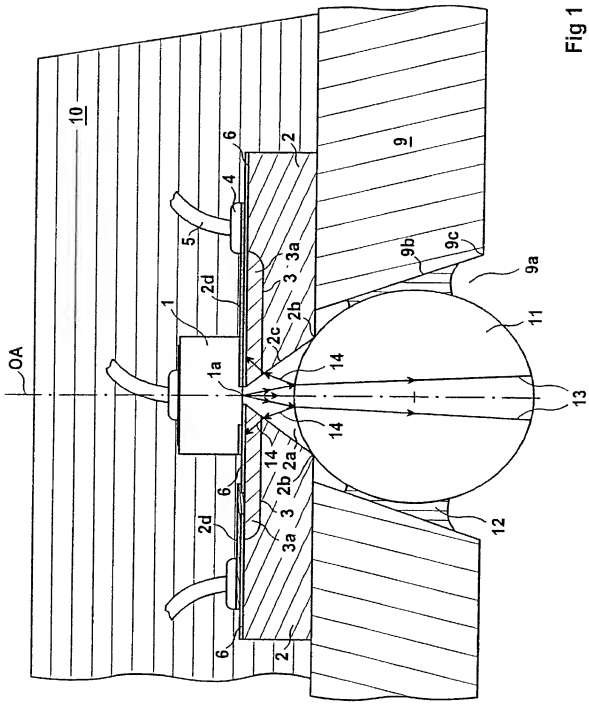


Fig 1

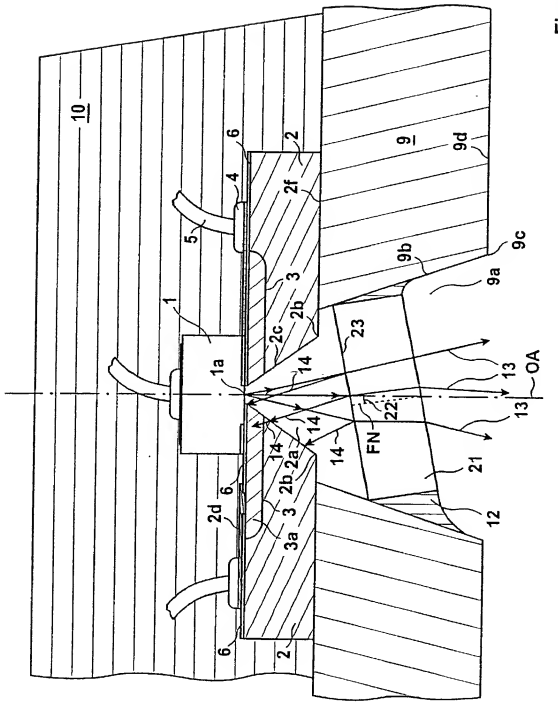
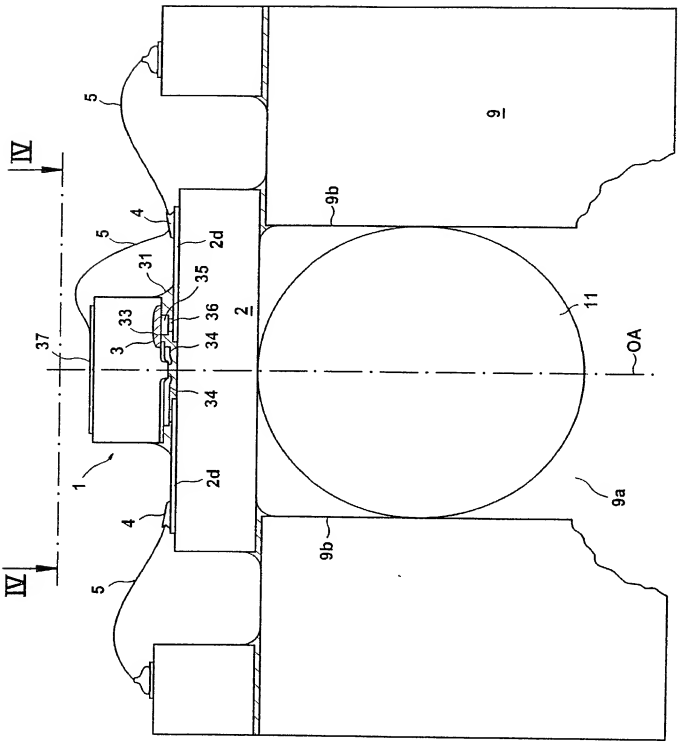


Fig 2

Fig 3



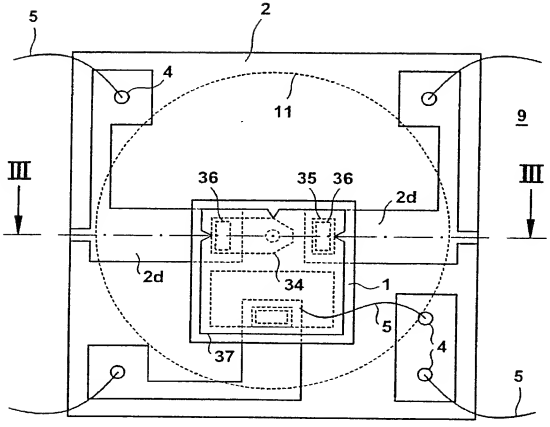


Fig 4

Express Mail Label No.

Docket No. 56881 (45107)

Declaration and Power of Attorney for Patent Application
English Language Declaration

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

"OPTOELECTRONIC COMPONENT AND METHOD FOR THE PRODUCTION THEREOF "

the specification of which

(check one)

[X] is attached hereto.
[ ] was filed on _____ as United States Application No. or PCT Application No. _____
and was amended on _____
(if applicable)

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d) or Section 365(b) of any foreign application(s) for patent or inventor's certificate, or Section 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Not Claimed
199 35 496.0 (Number)	Germany (Country)	28 July 1999 (Day/Month/Year Filed)	[ ]
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	[ ]
_____ (Number)	_____ (Country)	_____ (Day/Month/Year Filed)	[ ]

I hereby claim the benefit under 35 U.S.C. Section 119(e) of any United States provisional application(s) listed below:

(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)
(Application Serial No.)	(Filing Date)

I hereby claim the benefit under 35 U.S.C. Section 120 of the United States application(s), or Section 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. Section 112, I acknowledge the duty to disclose to the United States Patent and Trademark office all information known to me to be material to patentability as defined in Title 37, C.F.C., Section 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application:

(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
PCT/DE00/02295	13 July 2000	Pending
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)
(Application Serial No.)	(Filing Date)	(Status) (patented, pending, abandoned)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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